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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference XA1807		FOR FURTHER ACTION		See Form PCT/PEA/416
International application No. PCT/GB2004/003652		International filing date (day/month/year) 27.08.2004	Priority date (day/month/year) 29.08.2003	
International Patent Classification (IPC) or national classification and IPC G02B5/128, C03C12/02				
Applicant BAE SYSTEMS PLC et al.				
<p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 7 sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p>a. <input checked="" type="checkbox"/> sent to the applicant and to the International Bureau a total of 3 sheets, as follows:</p> <p><input checked="" type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).</p> <p><input type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.</p> <p>b. <input type="checkbox"/> (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).</p>				
<p>4. This report contains indications relating to the following items:</p> <p><input checked="" type="checkbox"/> Box No. I Basis of the opinion</p> <p><input type="checkbox"/> Box No. II Priority</p> <p><input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p><input type="checkbox"/> Box No. IV Lack of unity of invention</p> <p><input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p><input type="checkbox"/> Box No. VI Certain documents cited</p> <p><input type="checkbox"/> Box No. VII Certain defects in the international application</p> <p><input type="checkbox"/> Box No. VIII Certain observations on the international application</p>				
Date of submission of the demand 29.06.2005		Date of completion of this report 13.09.2005		
Name and mailing address of the International preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465		Authorized Officer von Hentig, R Telephone No. +49 89 2399-7041 		

**INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY**

International application No.
PCT/GB2004/003652

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
- ☐ international search (under Rules 12.3 and 23.1(b))
 - ☐ publication of the international application (under Rule 12.4)
 - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages

1-9 as originally filed

Claims, Numbers

1-17 received on 29.06.2005 with letter of 28.06.2005

Drawings, Sheets

1/5-5/5 as originally filed

- ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☒ The amendments have resulted in the cancellation of:

- ☐ the description, pages
- ☒ the claims, Nos. 18
- ☐ the drawings, sheets/figs
- ☐ the sequence listing (*specify*):
- ☐ any table(s) related to sequence listing (*specify*):

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/figs
- ☐ the sequence listing (*specify*):
- ☐ any table(s) related to sequence listing (*specify*):

* If item 4 applies, some or all of these sheets may be marked "superseded."

**INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY**

International application No.
PCT/GB2004/003652

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	2,5,8,17
	No: Claims	1,3,4,6,7,9-16
Inventive step (IS)	Yes: Claims	2
	No: Claims	1,3-17
Industrial applicability (IA)	Yes: Claims	1-17
	No: Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Re Item V

**Reasoned statement with regard to novelty, inventive step or industrial applicability;
citations and explanations supporting such statement**

1. The following documents D1 - D5 are referred to in this communication; the numbering will be adhered to in the rest of the procedure:

D1: WO 97 23423 A (RASSING JOERGEN; AKZO NOBEL NV (NL); NORSK HYDRO AS (NO); HALLENST) 3 July 1997 (1997-07-03)

D2: WO 97 23788 A (RASSING JOERGEN; AKZO NOVEL N V (NL); NORSK HYDRO AS (NO); HALLENS) 3 July 1997 (1997-07-03)

D3: DE 12 52 856 B (MINNESOTA MINING & MFG) 26 October 1967 (1967-10-26)

D4: GB-A-1 477 175 (EIGENMANN LUDWIG) 22 June 1977 (1977-06-22)

D5: YASUHIRO KOIKE ET AL: 'SPHERICAL GRADIENT-INDEX POLYMER LENS WITH LOW SPHERICAL ABERRATION' APPLIED OPTICS, OPTICAL SOCIETY OF AMERICA, WASHINGTON, US, vol. 33, no. 16, 1 June 1994 (1994-06-01), pages 3394-3400, XP000450231 ISSN: 0003-6935

2. The application does not meet the requirements of Article 6 PCT for the following reasons: -

Dependent claim 17 lacks clarity due to the ambiguous term "refractive index distribution which averages across a radial cross-section ...". The present wording leaves doubts as to the calculation of the average index distribution across a radial cross-section remains indefinite.

3. The present application does not meet the requirements of Article 33(1) PCT concerning novelty and inventive step in the sense of Article 33(2) PCT and 33(3) PCT for the following reasons:-

- a. The subject matter of claim 1 is not novel over the disclosure of document D1

because document D1 discloses a spherical bead retro-reflective device comprising all the features of claim 1 (references in parentheses applying to this document):

A retroreflective device comprising a substantially spherical graded refractive index lens (figure 1), a reflective part (3) for retroreflecting a radiation beam passing through the graded refractive index lens and, at least partially surrounding the lens, a non-gaseous transparent material having a substantially uniform refractive index (5), wherein said graded refractive index lens (1, 2) has a spherically symmetric refractive index distribution.

Although the spherically symmetric refractive index distribution is not explicitly mentioned in document D1 this feature is, however, implicitly disclosed by document D1. The glass beads (page 2, lines 1-2) forming the core of the graded refractive index lens are surrounded by a continuous layer or film (page 3, lines 8-9). Hence, these spherical coated glass beads covered by a film (page 3, lines 14 -17) inevitably exhibit a spherically symmetric refractive index distribution.

For the sake of completeness, it may be added that also documents D2 and D3 discloses retroreflecting elements (see D2, figures 3, 4, 5 und D3, figure 2) having all the features recited in claim 1.

- b. Notwithstanding the novelty objection given above, the use of spherical gradient index lenses in common retro-reflective sheets has obvious and predictable advantages. These well identified advantages comprise low spherical aberration and the almost perfect focusing (see D5 Introduction paragraph 1, figure 11) which are desirable to obtain a high reflectivity. It may also be referred to the teaching of document D4 disclosing spherical gradient index lenses associated with light reflective layers (see figure 4, page 1, lines 8-14 and page 2 lines 52-60).

- c. The subject-matter of dependent claims 3, 4, 6, 7, 9-16 is not novel since the retro-reflecting elements disclosed by documents D1, D2, D3 and D4 comprise all the features defined in said dependent claims. In particular, the features of following claims are disclosed by the documents at the positions indicated:
- claim 3: Document D2, figure 2 with $n_1 < n_2 < n_3$
claim 4: Document D2, figure 2 with $n_1 < n_2 < n_3$
claim 6: Document D3, column 9, lines 34-38
claim 7: Document D1, figure 2
claim 9: Document D1, figure 2
claim 10: Document D1, figure 2
claim 11: Document D1, figure 2, $r(\text{inner transparent surface}) = r(\text{refl. surface})$
claim 12: Document D1, figure 2, $r(\text{outer transparent surface}) = \infty$
claim 13: Document D1, figure 2, $r(\text{outer transparent surface}) = \infty$
claim 14: Document D1, figure 2
claim 15: Document D1, page 4, lines 16-24
claim 16: Document D1, page 1, lines 14/15
- d. Dependent claims 5 and 17 are not regarded as defining inventive subject matter since the recited features follow the design of the bead disclosed by document D2 with $n_1 < n_2 < n_3$ and the refractive indices taking on values of commonly used types of glass.
- e. Dependent claim 8 is not regarded as defining inventive subject matter either. The substitution of spherical glass lenses by gradient-index lenses would be a straightforward possibility for the skilled person with obvious advantages, due to the low spherical aberration of these lenses and the nearly perfect focusing as laid out in D4 (page 2 lines 4 -22 and lines 52 - 60) and documents D5 (Introduction, Conclusion).
- f. An independent claim based on claims 1, 2 and 3 would have met the provisions of Articles 33(1) PCT and 6 PCT in view of the distribution of

refractive indices defined in dependent claim 3 which is a prerequisite to the retroreflective properties of the refractive index lens. It is evident from the description (page 8) that the following refractive index at the centre has to be greater than the refractive index at the outer surface of the graded refractive index lens so as to focus the light close to the surface of the lens.

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CLAIMS

1. A retroreflective device comprising a substantially spherical graded refractive index lens, a reflective part for retroreflecting a radiation beam passing through the graded refractive index lens and, at least partially surrounding the lens, a non-gaseous transparent material having a substantially uniform refractive index, wherein said graded refractive index lens has a spherically symmetric refractive index distribution.

2. A device according to claim 1, wherein said refractive index distribution includes parts having at least two separate radial extents within which the material of the lens has a continuously varying refractive index, the refractive index variation having a gradient discontinuity between said two radial extents.

3. A device according to any preceding claim, wherein said graded refractive index lens has a refractive index at its centre which is greater than a refractive index at its outer surface.

4. A device according to any preceding claim, wherein said transparent material has a refractive index which is less than a refractive index of said graded refractive index lens at its outer surface.

5. A device according to any preceding claim, wherein a ratio of the refractive index of said graded refractive index lens at its outer surface to a refractive index of said transparent material is between 1 and 2.

6. A device according to any preceding claim, wherein a ratio of the refractive index of said graded refractive index lens at its centre to a refractive index of said transparent material is between 1 and 2.

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7. A device according to any preceding claim, wherein said transparent material surrounds at least approximately one half of the lens.

8. A device according to any preceding claim, wherein at least part of said transparent material is located between said graded refractive index lens and the reflective part.

9. A device according to any preceding claim, wherein said reflective part includes a substantially spherical reflective surface arranged concentrically with respect to said graded refractive index lens.

10. A device according to any preceding claim, wherein a boundary of the transparent material remote from said lens, and through which a radiation beam passes to be retroreflected, is defined by a substantially spherical transparent surface arranged concentrically with respect to the graded refractive index lens.

11. A device according to claim 9 and 10, wherein said substantially spherical reflective surface and substantially spherical transparent surface have substantially the same radius of curvature.

12. A device according to claim 9 and 10, wherein said substantially spherical reflective surface and substantially spherical transparent surface have different radii of curvature.

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13. A device according to claim 12, wherein said substantially spherical reflective surface has a smaller radius of curvature than that of said substantially spherical transparent surface.

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14. A device according to any of claims 1 to 8, wherein a boundary of the transparent material remote from said lens, and through which a radiation beam passes to be retroreflected, is defined by a substantially planar surface.

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15. A device according to any preceding claim, wherein said transparent material comprises a solid moulded component.

5 16. A device according to any preceding claim, wherein said transparent material has a refractive index greater than 1.3.

10 17. A device according to any preceding claim, wherein said graded refractive index lens has a refractive index distribution which averages, across a radial cross-section, between 1.4 and 1.8.

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